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circumstances, too, the extremely low intervals perceptible are not surprising. The usual method was to make a decision on the first pair, and then see if the others confirmed it. In the two-second series rhythm was generally noticeable and helpful; the one-second rate was most agreeable and pleasant; the half second very lively; the four-second "deathly slow" and "nervous." It should be mentioned that at the fastest rate the apparatus did not always function perfectly, occasionally skipping a click or flash. Subjective control and introspective analysis of method seemed also quite difficult at this rate, and here S. reported that the clicks and flashes failed to combine, but formed independent series.

To recapitulate briefly, this study has shown:

1. That the flash-click order can be recognized when the interval is shorter than that required for the click-flash order.
2. That this holds true for a series of pairs of stimuli as well as for a single pair.
3. That the serial repetition of the pairs materially reduces the time interval necessary for right judgment.
4. The cause of this seems to be a retardation of the click due to greater attention-claiming quality attaching to the flash.

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### XIII. THE TIME REQUIRED FOR RECOGNITION.

By F. W. COLEGROVE.

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The method employed in the following rough study was extremely simple. Sixty-eight pictures, three to four inches in length and two to three inches in height, were cut from an old magazine and pasted upon cards. These were inserted, one at a time, in the clips of the Cattell Fall-chronometer and exposed by the sudden falling of the screen. At the instant of exposure, the falling screen released one pendulum of an electrical vernier chronoscope, the other being released by the subject as soon as he was able to decide whether he had seen the picture before or not.<sup>1</sup> If the picture was recognized, the subject reacted with his right hand; if unrecognized, with his left. Five or six reactions to the letters R (right) and L (left) were taken before and after each sitting, and the discrimination times thus found furnish both a control of the other experiments and a means of finding the pure recognition time free of all peripheral processes.

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<sup>1</sup> For the mode of operating the vernier chronoscope, see this *Journal*, Vol. IX, 191-7, Jan., 1898.

In the tables below, however, these simple discrimination times have not been deducted, but, on the contrary, the full time of response has been retained.

Five subjects were tested, all of whom had had some laboratory experience and two of whom had had a good deal. Five pictures, numbers 1, 2, 6, 44 and 68, were shown each subject before beginning and he became familiar with them. He also saw them again before each sitting. In what follows they are termed the "well-known pictures." On the first day of experimenting these were shown in irregular order with other pictures from the series. On the second day both the "well-known pictures" and the new ones of the first day could be drawn upon as known pictures to mix with a second group of unknown pictures; and on the third day the pictures of both the first and second days, and so on.

A considerable mass of records was thus obtained, both for the time required for recognizing the "well-known pictures," and for the time required for other pictures after one, two, three, four or more exhibitions. It is hardly necessary to mention that the first recognition, except in cases of mistaken reactions, occurs on the second exhibition and so on. The results for the earlier and later recognitions of the well-known pictures are given in Table I. In forming this table, the series of recog-

TABLE I.  
*Showing Times for Signaling the Recognition of the Well-known Pictures; Times in 0.001 Seconds.<sup>1</sup>*

Subject.	EARLIER RECOGNITIONS.			LATER RECOGNITIONS.		
	No. of Observat'ns.	Time of Recognition.	M. V.	No. of Observat'ns.	Time of Recognition.	M. V.
W	15	524	58	15	451	35
Y	22	490	119	27	432	38
S	17	615	65	19	516	55
K	23	571	124	26	474	68
Q	23	434	110	23	424	71
Average,	527			459		

<sup>1</sup>The times are given in the usual unit for convenience of the reader, though, as the unit of the chronoscope itself was 0.02, no significance is attached to the third figure of the results. It might be expected that with the method of division described in the text the number of

TABLE II.  
*Showing Times for Signaling Successive Recognitions of Pictures other than the Well-known Group.*

	W			Y			S			K			Q		
	No. of Obs.	Time.	M. V.	No. of Obs.	Time.	M. V.	No. of Obs.	Time.	M. V.	No. of Obs.	Time.	M. V.	No. of Obs.	Time.	M. V.
1st rec.	19	705	111	33	550	100	15	644	129	26	625	124	25	490	95
2 "	15	597	82	26	516	99	15	667	101	28	634	139	14	533	98
3 "	6	527	47	13	522	75	6	550	73	17	606	114	4	465	83
4 "	2	530	50	3	587	142	1	540	60	12	515*	78	1	620	—
5 "	1	480	—	2	470	10	1	620	—	5	496	59	1	520	—
6 "	1	440	—	—	—	—	—	640	—	1	540	—	—	—	—
7 "	1	500	—	—	—	—	—	—	—	1	520	—	1	400	—
Average	45	622		77	533		40	633		90	600		46	502	

\* One record, nearly 3 times as large as any other, was omitted from this average.

nitions for each picture was divided in the middle, if the number of recognitions was even, and the first part taken for the column of earlier recognitions, the second for that of later recognitions. If the number was odd and the full series could not be evenly divided, the middle term was discarded and the remaining parts treated as if the series had been even.

These figures show that the full time of signaling the recognition of a well-known picture lies somewhere between 424 to 615, and that it is shorter in the second half, where the familiarity was greater. This quickening may be due in part to increased skill in reacting. Two of the five subjects show a similar gain in reacting to the letters R and L, and with one subject, Q, the difference is more than that between the early and late trials in Table I, making the pure recognition times respectively 68 and 89. But it must be due chiefly to increasing familiarity with the pictures. Four of the five subjects show the same relation in the pure recognition times as in the table. The average pure times, found by subtracting 316 and 311 from 527 and 459 respectively, are 211 and 148.

The same thing is shown, though somewhat irregularly, when the successive recognitions of other pictures are examined, as in Table II.

How this increased speed of recognition should be regarded, whether as a hastening of the recognition process or as a gradual change in the character of that process from one which is more or less conscious toward one which is wholly automatic, or as involving both tendencies, is, unfortunately, not shown by the data at hand.

Beside this general question there are several of a subordinate interest, namely: Is there any difference in quickness of response when a picture is signaled as unrecognized? Is the quickness of response different when errors are made, *i. e.*, when a known picture is signaled as unknown, or *vice versa*? Is there any difference in the quickness with which different pictures are recognized? Such data as the experiments have furnished upon these points are gathered in the following paragraphs.

In Table III the time for the *first recognitions* has been taken from Table II, instead of the average time of all recognitions, as corresponding more nearly with the condition present when the pictures (before unknown) are signaled as unrecognized. It will be observed that three subjects (W, S and K) take longer to determine and signal a recognized picture than an unrecognized one; and two, Y and Q, take longer for the unrecog-

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observations would be the same for the same subject in both early and later recognitions, and such would be the case except for differences introduced by failures in the functioning of the apparatus, and by erroneous reactions on the part of the subjects.

TABLE III.

*Showing Comparative Quickness in Signaling Recognized and Unrecognized Pictures.*

Sub- ject.	RECOGNIZED PICTURES.			UNRECOGNIZED PICTURES.		
	No. of Cases.	Time.	M. V.	No. of Cases.	Time.	M. V.
W	19	705	111	52	618	111
Y	33	550	100	40	583	88
S	15	644	129	48	587*	95
K	26	625	124	49	586	121
Q	25	490	95	43	564	99

\*One record, nearly four times as large as that next it in size, was omitted in making this average.

TABLE IV.

*Showing Comparative Quickness in Erroneous Reactions.*

Sub- ject.	WRONGLY SIGNED AS KNOWN.			WRONGLY SIGNED AS UNKNOWN.		
	No. of Cases.	Time.	M. V.	No. of Cases.	Time.	M. V.
W	9	624	200	20	617	88
Y	19	536	118	27	586	116
S	6	550	137	15	635	98
K	10	614	128	31	570	105
Q	16	461	71	10	516	140

nized. This appears to be due to a difference in mental attitude, which will perhaps be clearer after a consideration of the results where errors were made. Y, Q and K show the same tendencies in Table IV as in Table III; the times of W when in error are practically the same without regard to the nature of the error; while for S the relation of Table III is reversed. The small number of cases and the large M. V. make it seem likely that this difference in the case of S is accidental, and examination of the separate determinations confirms that opinion.

The proportion of errors of each sort for the different subjects is, however, more characteristic than the times. The percentage of cases in which the error consisted in signaling as known a picture which had not really been seen before, is as follows: W 31, Y 41, S 29, K 24 and Q 62. W, S and K evidently tend less to false recognitions than Y and Q. Furthermore, if the records of the observers in all the tables be compared, it will be found in every case that subject Q made the quickest responses, and that in every case but one (*i. e.*, in wrongly signaling known pictures as unknown, Table IV, second half), Y stands next him in speed, while K, W, and S are always slower, though their order among themselves is different in different tables. Y and Q appear to err by being hasty.

The first inference, perhaps, would be that Q and Y belong to the motor type of reagents and carried their motor habit into these recognition experiments; and there was more or less in Q's manner of reacting to justify such an inference. Yet, if this were the case, something of the same tendency ought to appear in the records for signaling the presence of the letters R and L. The records, however, fail to show such a tendency; Q is slow as compared with the rest, and Y, though quick in the early part of the series, was excelled by both S and W in the latter part. It seems more probable, therefore, that Q and Y were somewhat on the lookout for known pictures, while the rest expected unknown pictures.

The grading of the pictures according to their difficulty of recognition was made on the basis of the errors recorded against them and checked by a subsequent calculation of the times required for certain special groups; all of the "well-known" pictures were excluded in this consideration.

Ten pictures had no errors at all or but a single failure in recognition recorded against them. They gave, together, thirty-three recognition times, with an average value of 568, and a M. V. of 111. Six pictures, on the other hand, failed of recognition on four or more occasions. These gave, together, nineteen recognition times, with an average value of 583 and a M. V. of 155.

Any statement of reasons for this slowness must be largely conjectural, but the pictures recognized with difficulty seem lacking in interest, either in the situation presented or because they involve a multitude of nearly co-ordinate details. The pictures that were most often recognized falsely (*i. e.*, signaled as known when shown for the first time), were a group of three drawings of country houses, all executed in a similar and somewhat peculiar manner, and not easily distinguishable in their general aspects, though offering no difficulty when placed side by side. Next these in suffering errors of this kind was a group of eleven

pictures, a number of which showed resemblance in subject or treatment to other pictures in the series. As was to have been expected from the nature of the experiment, the general effect is more important in both cases than details.

The general results of this study may be summed up as follows: The central processes of recognition in the case of ordinary magazine pictures take place in a fifth of a second or less, on the average, the time decreasing as the familiarity increases. Whether the judgment that a picture is known takes place more quickly than the judgment that it is unknown, seems to depend on the mental attitude of the subject—more quickly if he expects the exhibition of known pictures, less quickly if he expects the reverse. Differences in the facility of recognition are found with different pictures, depending chiefly, it would seem, upon their ability to arouse interest, or, in other words, to compel attention.

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#### XIV. NOTES ON MENTAL STANDARDS OF LENGTH.

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By F. W. COLEGROVE.

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The ability to make estimates of length presupposes some sort of mental standard which is applied to the length in question. The existence of such standards is very easy to demonstrate, and has even been found a serious obstacle in certain forms of psychophysical experimentation. Some effort has been made to find how accurately these mental standards coincide with the external units that they represent, but so far as the writer is aware no one has tried to investigate the nature of these scales and their mode of application. The present fragment unfortunately does not go far toward filling this gap, but may, at least, call attention to the matter as a subject for investigation. It would be interesting from the point of view of individual psychology if we could know, for a considerable number of persons, the nature and origin of their full equipment of mental standards—for weight, capacity, temperature, angular measure and money value, as well as for length.

The method of the present study was simple in the extreme, and the results can be briefly stated. Fifty circles, differing in diameter by sixteenths of an inch, and forming a continuous series from one and a half inches to four and nine-sixteenths inches, were drawn upon cards of convenient size. A similar set of straight lines of length equal to the diameters of the circles was also prepared, and was submitted with the circles to the subjects for estimation. The subjects were ten in num-